

Horn Coupled Multichroic Polarimeters with Comprehensive Frequency Coverage and Integrated Readout for Future CMB Missions

Completed Technology Project (2017 - 2019)



Project Introduction

Precision measurements of the cosmic microwave background (CMB) have the potential to transform our understanding of cosmology and fundamental physics. A detection of B-mode polarization on large angular scales can reveal the existence of gravitational waves produced in the earliest moments of the universe, during the epoch of inflation. If detected, this signal would probe physics near the Grand Unification energy scale. The detection of the B-mode signal requires not only high-sensitivity and control of instrument systematics but also requires astrophysical foreground characterization and separation. Measurements with broad frequency coverage subdivided into many bands offer the best solution to this challenge. We propose to develop novel arrays of feedhorn-coupled, multichroic polarimeters that maximize sensitivity, control systematic effects, and provide comprehensive frequency coverage (25-650 GHz) to characterize and remove foregrounds to enable measurement of the faint inflationary signatures in the CMB. We further propose to demonstrate a transformative wafer-level integration of bolometric sensors and multiplexed readout that drastically reduces focal plane complexity, cost, and mass. We will achieve these goals by scaling existing 2:1 ratio bandwidth designs to different frequency bands, increasing the number of spectral bands per spatial pixel, and exploring a new detector architecture, based on quadrupole-ridge waveguide coupling that achieves 3:1 ratio bandwidth. Power sensing is achieved with sensitivity and low-frequency stability proven superconducting transition-edge sensors (TES) bolometers, and these sensors are read out with an on-wafer integrated microwave SQUID multiplexer. This aspect of the proposed work enables TES detectors to acquire the same straightforward multiplexing architecture as microwave kinetic inductance detectors (MKIDs) while retaining the sensor qualities that have made TESs the workhorse of CMB science. The proposed work will boost sensitivity, increase spectral resolution, reduce focal plane mass, and vastly simplify focal plane integration for future satellite missions. This detector architecture represent a logical technology for a definitive all-sky CMB polarization satellite experiment.



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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

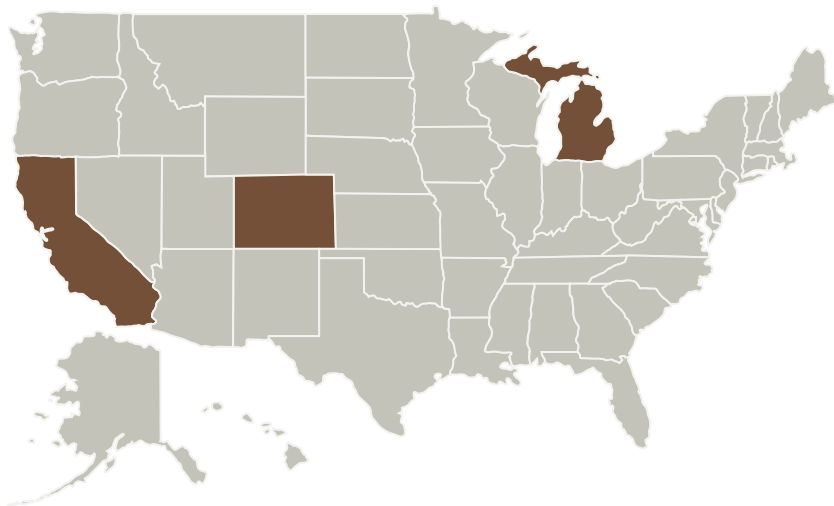
Astrophysics Research and Analysis

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

Primary U.S. Work Locations	
California	Colorado
Michigan	

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

Jeff McMahon

Co-Investigators:

James A Beall
 Tracy M Mausolf
 Jason E Austermann
 Johannes Hubmayr
 Gene C Hilton
 Shannon M Duff
 Kent D Irwin

Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.1 Remote Sensing Instruments/Sensors
 - └ TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System